PATENT SPECIFICATION

Application Date: Feb. 14, 1929. No. 5064/29. 321,892

Complete Left: July 1, 1929.

Complete Accepted: Nov. 21, 1929.

PROVISIONAL SPECIFICATION.

An Improved Diaphragm Valve.

I, PHILIP KEITH SAUNDERS, of Saunders Inventions Limited, of 98, Beresford House, Main Street, Johannesburg, Union of South Africa, a British Subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to valve of the kind wherein an obturating member in the form of a flexible diaphragm is arranged in regulating the rate of flow of fluid through the valve to co-act with a seating between ports communicating with the inlet to and outlet from the valve respectively.

The object of the present invention is to provide an improved form of construction of such valves which whilst applicable to the control of fluids generally shall be more especially suitable for regulating fluids of substantial density or fluids travelling at high velocities.

According to the present invention the valve body is formed with a substantially straight through bore or passage intersected by a shallow weir extending across the bore and part way only of its height and having a concave spherical upper face forming the seating with which the diaphragm co-operates. The entry passage which starts circular in cross-section diminishes gradually in height as it approaches the weir but increases in width simultaneously so as to maintain the cross-section of the bore substantially constant. The dimensions of the outlet port vary in converse manner. The diaphragm is clamped between flanges on the valve body and its cover and may be actuated mechanically as by a screw threaded spindle or alternatively by the application to the upper side of the diaphragm of fluid pressures above and below the value of that existing below the diaphragm.

In one way of carrying the invention into practical effect as applied to a diaphragm valve with a screw spindle as actuating means the valve body is cast with a substantially straight through bore or passage, the base wall of the body rising gradually from the inlet and outlet ends to a shallow weir intersecting the bore of the valve body intermediate its ends. The body is widened correspondingly at its centre of length in order to maintain the cross section of the valve passage when open as far as possible constant throughout its length. On its upper side the body is formed with a low annular flange to which the flexible diaphragm and the valve cover are adapted to be bolted. The space within this flange is occupied by a concave spherical recess into which the inlet and outlet emerge in D shaped ports separated by the upper edge of the weir above referred to.

On its upper side the diaphragm is engaged by a rigid backing member guided in the cover so as to be capable of sliding axially therein without rotating and operatively connected with said backing member is the screw spindle arranged to be actuated by a hand wheel or equivalent means outside the cover of the valve. The backing member which extends transversely of the valve body has a curved underface corresponding with and opposed to the spherical upper face of the weir and operates when depressed by the screw spindle in pressing the diaphragm tightly upon the upper face of the weir. In order that in all positions of the valve the diaphragm may be supported against the pressure of the fluid acting below, the backing member and the valve cover are formed with projecting fingers which mesh one with another, these having upwardly curved under faces adapted to bear the load upon the diaphragm in its different positions.

The curvature of the seating and of the diaphragm supporting fingers and the extreme travel of the screw spindle are so arranged that the diaphragm is subjected to the same degree of deformation or flexure when fully open as when fully shut, as by this means the greatest possible cross section of flow is obtained for a minimum of deformation or flexure of the diaphragm.

In a modified form of construction the screw spindle and the backing member for actuating the diaphragm are dispensed with and the valve is controlled instead by the action of fluid pressure on the upper side of the diaphragm. In this

[Price 1/-]

case the valve body is fitted with a cover having a concave spherical under face corresponding in curvature to that of the seating so that the diaphragm when fully open contacts closely with said cover. Means are provided whereby the fluid pressure existing between the cover and the diaphragm may be raised to a value in excess of that in the pipe controlled, for the purpose of closing the valve, or lowered below said pressure for the purpose of opening the valve.

As will be understood the diaphragm will be fully supported on its upper side by the fluid pressure existing within the cover or alternatively by the cover itself. In order however to support the diaphragm on its underside when closed, the D shaped ports in the seating are intersected by grids whose upper faces conform to the general spherical form of the seating, the webs comprised in the grids being preferably stream lined to the bore of the valve.

Hydraulic or pneumatic pressure may of course be employed for controlling the movements of the diaphragm or alternatively where no such supplies of pressure are available small hand pumps and pressure gauges may be fitted to the valves for the purpose of applying to the diaphragm the pressure necessary for partly or fully closing the valve. A small cock or valve must also be provided for releasing such pressure when it is desired to open the diaphragm valve.

Dated this 14th day of February, 1929.

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40, Chancery Lane, London, W.C. 2,
Agents.

COMPLETE SPECIFICATION.

An Improved Diaphragm Valve.

I, PHILIP KEITH SAUNDERS, of Saunders Inventions Limited, of 98, Beresford House, Main Street, Johannesburg, Union of South Africa, a British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to valves of the kind wherein an obturating member in the form of a flexible diaphragm is arranged in regulating the rate of flow of fluid through the valve to co-act with a seating between ports communicating with the inlet to and the outlet from the valve respectively.

Now the present invention has for its object to provide an improved construction of such valves which when opened shall afford for the fluid controlled a stream lined and nearly straight passage permitting of a high velocity flow without inducing substantial resistance such as would be encountered in valve bodies of the well known type having ports arranged concentrically with reference to an annular seating. It is also an object of the present invention to provide an improved construction of diaphragm valve which whilst applicable to the control of fluids generally, shall be especially suitable for regulating the flow of fluids of substantial density or fluids travelling at high velocity.

A further object of this invention is to produce a heavy duty valve, that is, one capable of controlling large or relatively large quantities of fluid at high or relatively high pressure, which valve shall be easily operated by manual means. Still another object of this invention is to provide means whereby the diaphragm shall in all positions be supported against the fluid pressure to which it is subjected.

With these and other objects in view, the present invention consists primarily in providing the valve with a body having a substantially straight-through bore or passage intersected by a shallow weir which extends across the width of the bore and part way of its depth and is formed with a concave upper face that constitutes the seating with which the diaphragm co-operates. The bore or passage through the valve which is entirely devoid of sudden bends or angles which might induce eddies or otherwise impede a free flow of the fluid, curves gradually up to and down from the weir and the width of the body is enlarged at its centre of length to compensate for the reduction of height arising from the presence of the weir. In some cases the increase of width may be such as to obtain a bore or passage which gives a constant cross-sectional area throughout when the valve is fully opened. As however this sometimes results in a bulky and expensive construction it is frequently found expedient to so proportion the dimensions of the body that the bore therethrough when the valve is fully opened converges gradually by regular decrements from the inlet to the weir and diverges gradually by regular increments from the weir to the outlet

somewhat in the manner of the well known Venturi tube. In the convergent divergent form of construction the maximum constriction which occurs at a point where the weir is situated may represent ⅔ or more of the full bore at the inlet and outlet of the valve. The flexible diaphragm forming the closure member is clamped between flanges formed on the valve body and its cover, which flanges may be fluted, serrated or otherwise roughened on their abutting faces to increase the grip upon the diaphragm. The diaphragm itself is preferably composed of a rubberised fabric consisting of one or more layers of woven fabric connected together and coated on both surfaces with rubber, the coating of rubber being of a greater thickness on that side which co-acts with the valve seating. The seating itself is preferably faced as with an inset of rubber which is not subject to pitting and scoring as is metal and which may be readily renewed when required. This rubber inset also obviates any tendency on the part of the diaphragm to adhere in the closed position.

Actuation of the valve may be effected manually by screw mechanism or equivalent means which are arranged in the cover of the valve and include a rigid backing member that engages the diaphragm directly and when necessary presses it into close contact with the seating. This backing member carries also a plurality of fingers which intermesh with corresponding fingers provided in the cover of the valve, and these moving and stationary fingers co-operate one with another in supporting at all times the pressure applied to the underside of the diaphragm.

These and other features are hereinafter more fully described with reference to the accompanying drawings in which:—

Fig. 1 is a longitudinal sectional elevation of an improved diaphragm valve constructed in accordance with this invention, the valve being shown in the fully opened position.

Fig. 2 is a sectional plan of the same taken on the line 2—2 of Fig. 1,

Fig. 3 is a transverse sectional elevation of the valve in the fully closed position,

Fig. 4 is a sectional plan of the same taken on the line 4—4 of Fig. 3 and with the diaphragm removed.

Fig. 5 is a plan view partly in section illustrating a preferred form of diaphragm, and

Fig. 6 is a radial section of a portion of the flexible diaphragm of Fig. 5. shown on an enlarged scale.

Referring to these drawings which show a diaphragm valve of the screw-down type constructed according to this invention it will be seen that the valve body 1 is cast with a substantially straight through bore or passage 2, whilst the base wall 3 rises gradually from the inlet and outlet ends to a shallow weir 4 which has a concave upper face and intersects the passage 2 intermediate its ends. The body is widened correspondingly at its centre of length to ensure that a slight reduction only of cross-sectional area of the valve passage occurs at the centre of the valve when the latter is fully opened. Alternatively the valve body may be so dimensioned as to obtain a bore or passage of uniform cross-sectional area when the valve is opened. On its upper side the valve body 1 is formed with a low annular flange 5 to which the flexible diaphragm 6 and the valve cover 7 are adapted to be securely clamped as by nuts 8 screwing on to studs 9 fixed in the body. The faces of the flange 5 and the cover 7 which abut against the flexible diaphragm 6 are preferably formed with complementary ribs and grooves 10 to ensure a strong and fluid tight joint being made with the diaphragm. Alternatively these faces may be serrated or otherwise roughened to obtain a similar effect. The space within the flange 5 is occupied by a concave part-spherical recess into which the inlet and outlet emerge in substantially D-shaped ports separated by the upper edge of the weir 4. The internal surfaces of the valve body and of the cover 7 are rounded at all points where change of direction occurs and where contact is made with the flexible diaphragm, this being done in order that the fluid may pass unimpeded by the formation of eddies and also in order that the diaphragm may not be damaged by contact with any sharp edges of metal.

The flexible diaphragm 6 employed is preferably composed of india-rubber reinforced with a layer or layers of fabric connected together and coated on both sides with rubber which is vulcanised to render the construction strong and capable of resisting heavy wear, the rubber coating on the underside of the diaphragm, i.e., that which co-acts with the seating being of greater thickness than that on the reverse side, as shown in Fig. 5. As india-rubber when pressed for a time in contact with a surface of metal is apt to adhere, it is preferred to face the seating of the valve with rubber and for this reason the upper edge of the weir 4 is formed with a dovetail or undercut groove 11 adapted to receive a strip 12 of rubber of corresponding section which is cemented or otherwise secured in position in said groove, said strip extending

the full length of the weir and part way into the flange 5 where it is compressed tightly by the diaphragm 6.

On its upper side the diaphragm 6 is engaged by a rigid backing member which in the example illustrated comprises a transverse sector shaped compression bar 13, a longitudinal sector shaped bar 13^1 projecting at right angles thereto and further sector shaped bars or fingers 13^2 arranged on either side of and parallel with the central compression bar, the whole being made as an integral casting. The ends of the compression bar 13 project into and are guided in recesses 14 in the wall of the cover 7 and thus render the backing member as a whole capable of sliding axially within the cover without however rotating. An internally screw threaded sleeve 15 rigid with said backing member passes through a stuffing box 16 in the cover 7 and is operatively connected externally of the valve with a screw spindle 17 arranged to be actuated by a hand wheel 18. The boss of the hand wheel 18 is rotatably mounted in a bearing 19 formed in a yoke 20 connected to the valve cover and a Stauffer or other lubricator 21 may be provided upon said bearing.

The central sector shaped compression bar 13 which extends transversely of the valve is adapted when depressed to force the diaphragm 6 down on to the rubber inset 12 forming the facing to the weir and also onto the flanged edges of the body and thus to isolate completely the inlet port from the outlet port. The curvature of the underface of the backing member as a whole corresponds with that of the recess containing the inlet and outlet ports and the seating having regard to the thickness of the diaphragm itself. From the inner wall of the cover 7 projects fixed bars or fingers 22 having concave under faces corresponding to the curvature of the upper side of the diaphragm when the valve is opened. These fixed bars or fingers are aligned vertically with the spaces between the bars or fingers in the backing member 13 so that the fixed and moving fingers may mesh one with another as the valve is operated and co-operate in supporting the thrusts imposed by the pressure fluid acting on the underside of the diaphragm. The edges of the fixed and moving support fingers are well rounded in order to prevent damage being inflicted upon the diaphragm with which they contact. The position and the curvature of the under faces of the fixed support fingers is such as to enable the diaphragm when the valve is fully opened to acquire the same degree of flexure upwardly as it experiences in a downward direction when closed, thus giving a maximum effective area for flow with a minimum of distortion in the diaphragm. Though in the example just discussed the support fingers are arranged transversely and longitudinally of the valve they may be arranged in radial or any other formation desired.

In order to obviate undue compression of the diaphragm upon the seating as might occur due to the hand wheel 18 being screwed down too tightly, adjustable stop means may be provided taking the form of a collar 23 screwed upon the upper end of the sleeve 15 and adapted to be locked in any position of adjustment as by a grub screw 24. This collar is to be positioned upon the sleeve 15 as to abut firmly upon the gland of the stuffing box 16 when the diaphragm is compressed sufficiently for the purposes of closing the valve.

In the case of valves of large capacity or valves handling fluids at high pressures, the effort required for actuating the hand wheel 18 may become unduly large. This difficulty may however be overcome by introducing to the closed space within the cover 7 a fluid under pressure as for example, that being controlled by the valve, in order that it may by acting on the upper side of the diaphragm assist the operation of the valve. The pipe (not shown) for introducing this pressure fluid may be connected with the cover at 25 and any suitable auxiliary valve or cock device may be provided for regulating the admission of such pressure fluid and its release as and when necessary.

If the source from which the fluid under pressure is drawn exceeds the pressure of the fluid controlled by the valve, the actuation of the valve may be effected entirely by the manipulation of the auxiliary valve or cock and with such an arrangement it becomes possible to obtain control of the valve from any convenient position which may be more or less remote from the valve itself, with the additional advantage of being able to clamp the diaphragm positively to its seat when the valve is closed and thus prevent any unintended leakage through the valve due to relaxation of the fluid pressure from any cause whatever. Under ordinary conditions when the valve is to be actuated by means of fluid pressure as indicated, the hand-wheel 18 will first be turned to raise the backing member 13 to its uppermost position where it will leave the diaphragm free for operation. A packing washer 26 provided on the upper side of the backing member 13 then makes contact with the underside of the cover 7 and prevents leakage of fluid to the

stuffing box 16.

Now, as when the closing of the valve is assisted or effected entirely by the action of fluid pressure, there is a somewhat heavy load applied to the upper side of the diaphragm it is preferred to provide in the inlet and outlet ports support grids 27 preferably comprising stream lined intersecting webs cast integral with the valve body, the upper edges of said webs conforming to the spherical form of seating to the valve. In order to strengthen and at the same time to improve the appearance of the valve body particularly in valves of the larger sizes it is preferred to cast the body with a curved web 28 which on the underside of the valve connects the inlet and outlet flanges and encloses a space 29 beneath the weir 4 to which access may be had through a hand hole 30 provided for the removal of coring sand. This space 29 may conveniently be utilised for storage purposes and may be rendered secure by the provision of any suitable cover device for closing the aperture 30.

By lining the body of the valve with india-rubber, lead or other corrosion resisting material, a construction is obtained suitable for handling corrosive fluids or fluids which would normally be contaminated by contact with iron, or other material of which the valve body is formed.

Figs. 5 and 6 show a preferred form of construction of the flexible diaphragm wherein three separate layers of fabric reinforcement 31, 32, 33 are employed, these being incorporated in the structure with their threads running in different directions so as to ensure a high degree of strength in all radial directions. To prevent moisture gaining access to the fabric reinforcement and acting deleteriously thereon it is preferred to envelope the fabric entirely by the rubber covering. For this reason the fabric is, as shown in Fig. 5, made of slightly smaller diameter than the complete diaphragm, and is perforated near its edge with holes of a larger diameter than that of the studs 9 so that the rubber coating subsequently applied shall cover the fabric completely both at its edges and also about the stud holes. As has previously been stated the facing of rubber which is vulcanised throughout is thicker on the underside intended for contact with the seating.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An improved diaphragm valve comprising a body having a substantially straight through bore or passage intersected by a shallow weir extending across the width of the bore and part way of its depth said weir having a concave upper face that forms part of the seating with which the diaphragm co-operates.

2. An improved diaphragm valve according to claim 1, wherein the base wall of the bore or passage rises in a gradual curve from the inlet and outlet to the weir.

3. An improved diaphragm valve according to claim 1, wherein the width of the bore increases progressively towards the weir so as to provide a passage of flow which when the valve is fully opened is either constant in cross-sectional area throughout or only slightly constricted.

4. A diaphragm valve according to claim 1, wherein the body is formed centrally of its length with a low annular flange to receive the diaphragm and the valve cover, the space within said flange being occupied by a concave spherical recess into which emerge substantially D-shaped inlet and outlet ports separated by the weir.

5. A diaphragm valve according to claim 1, wherein the flexible diaphragm is clamped between a flat flange on the body of the valve and a flat flange on the cover and wherein the surfaces of metal adapted for contact with the moving parts of the diaphragm are curved gradually throughout.

6. A diaphragm valve according to claim 1, wherein the upper edge of the weir is grooved and contains an inset of rubber forming a seating upon which the diaphragm may be clamped, the ends of the inset being gripped between the flanges on the body and the cover.

7. A diaphragm valve according to claim 1, including a diaphragm of reinforced rubber clamped between the body and its cover and screw mechanism in the cover for actuating the diaphragm.

8. A diaphragm valve according to claim 1, wherein the flexible diaphragm comprises a layer or layers of fabric cemented together and coated with india-rubber, the coating of rubber on the under or operative surface being thicker than that on the remote side.

9. A diaphragm valve according to claim 5, wherein the layers of reinforcing fabric are laid with their threads running in different directions.

10. A diaphragm valve according to claim 1, including screw mechanism and a backing member for actuating the diaphragm, the backing member comprising a diaphragm compressing bar and diaphragm supporting bars or fingers which

latter intermesh with stationary diaphragm supporting bars or fingers on the cover.

11. A diaphragm valve according to claim 10, wherein the diaphragm compressing bar is guided at its ends in recesses in the cover and operates in compressing the diaphragm not only upon the valve seating formed upon the weir but also in part upon the flange of the body adjacent the cover.

12. A diaphragm valve according to claim 11, wherein the moving and stationary diaphragm supporting bars or fingers are so shaped that the diaphragm assumes a spherical shape in both its extreme positions and is equally distorted in either position.

13. A diaphragm valve according to claim 7, wherein stop means are provided on the screw mechanism to limit the degree of compression to which the diaphragm is subjected when the valve is closed.

14. A diaphragm valve according to claim 1, wherein diaphragm supporting grids are formed or provided in the inlet and outlet ports on either side of the weir.

15. A diaphragm valve according to claim 1, wherein the cover of the valve is rendered fluid tight and fliud under pressure is admitted thereto as and when required to assist or to effect operation of the valve diaphragm.

16. A diaphragm valve according to claim 2, wherein a curved strengthening web cast upon the body encloses a space beneath the weir utilisable as a storage space.

17. A diaphragm valve according to claim 1, having a lining of india-rubber, lead or other corrosion-resisting material for the purpose specified.

18. The improved diaphragm valve substantially as herein described with reference to the accompanying drawings.

Dated this 28th day of June, 1929.

WHEATLEY & MACKENZIE,
40, Chancery Lane, London, W.C. 2,
Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1929.

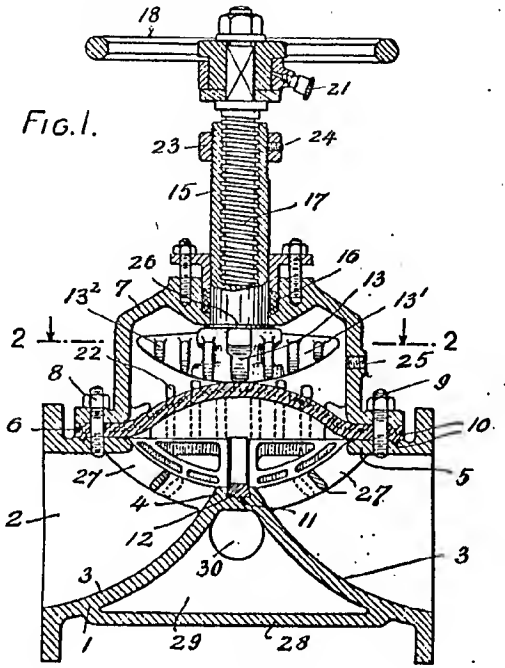


FIG. 1.

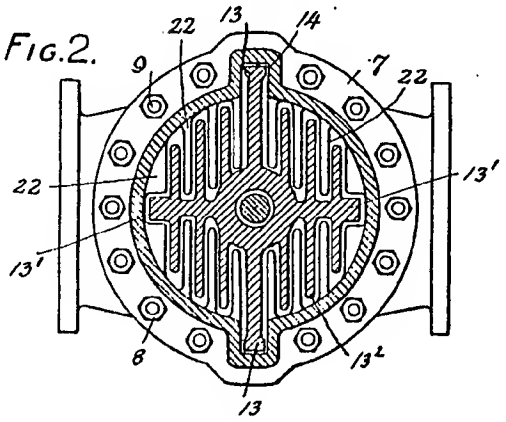


FIG. 2.

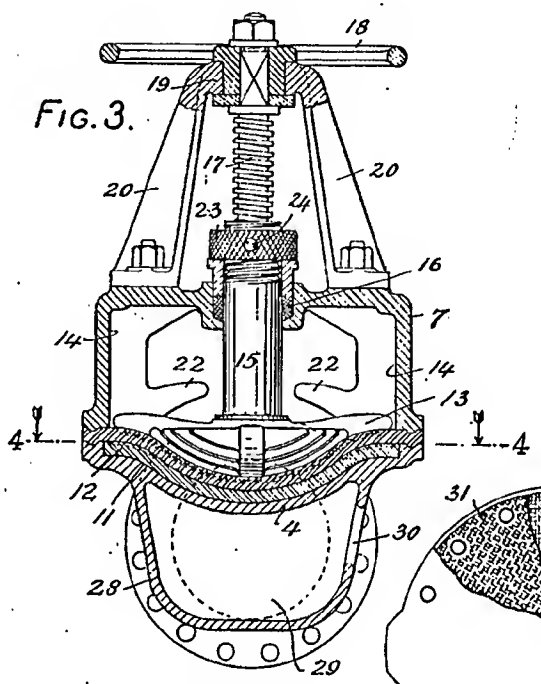
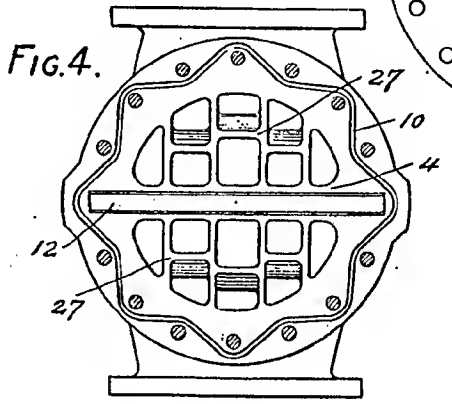


FIG. 3.



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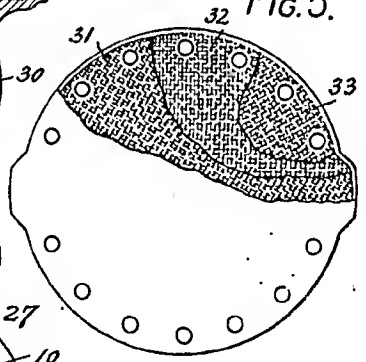

FIG. 5.

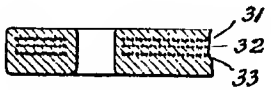

FIG. 6.

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[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

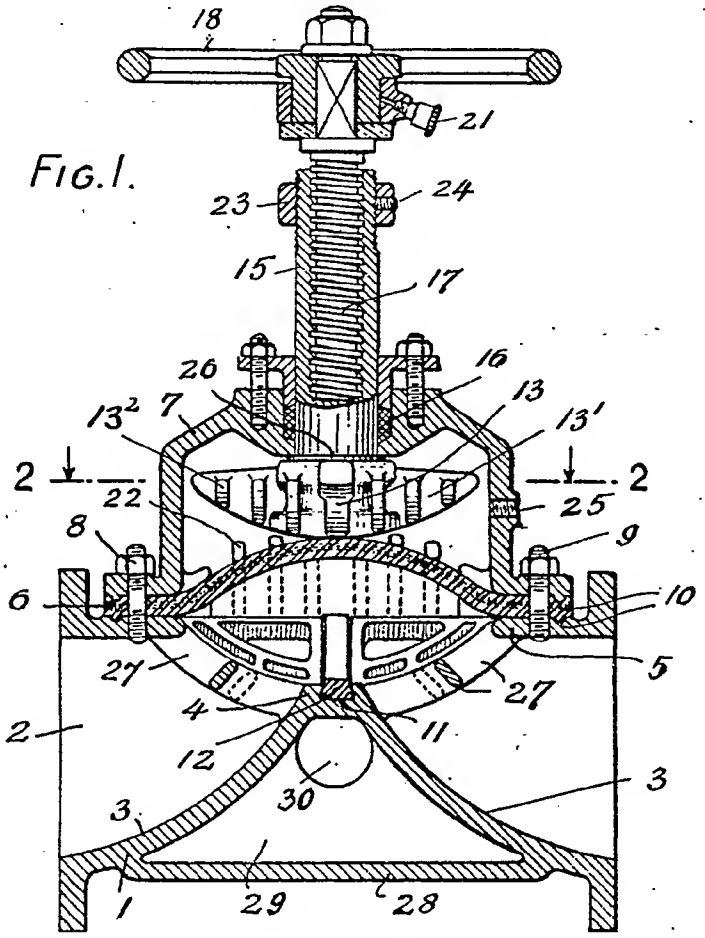


FIG. 2.

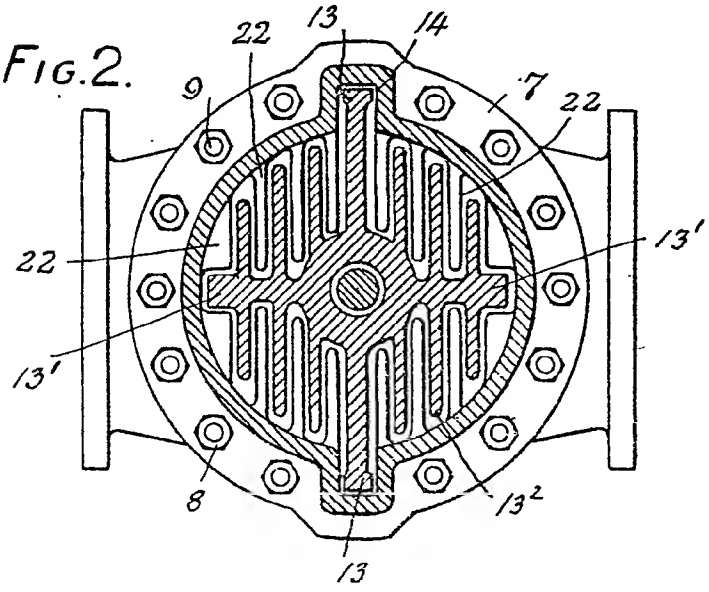


FIG.

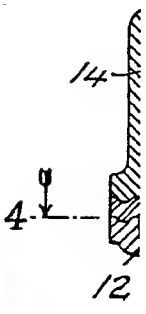


FIG.4

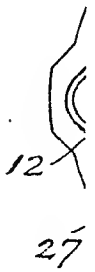


FIG. 3.

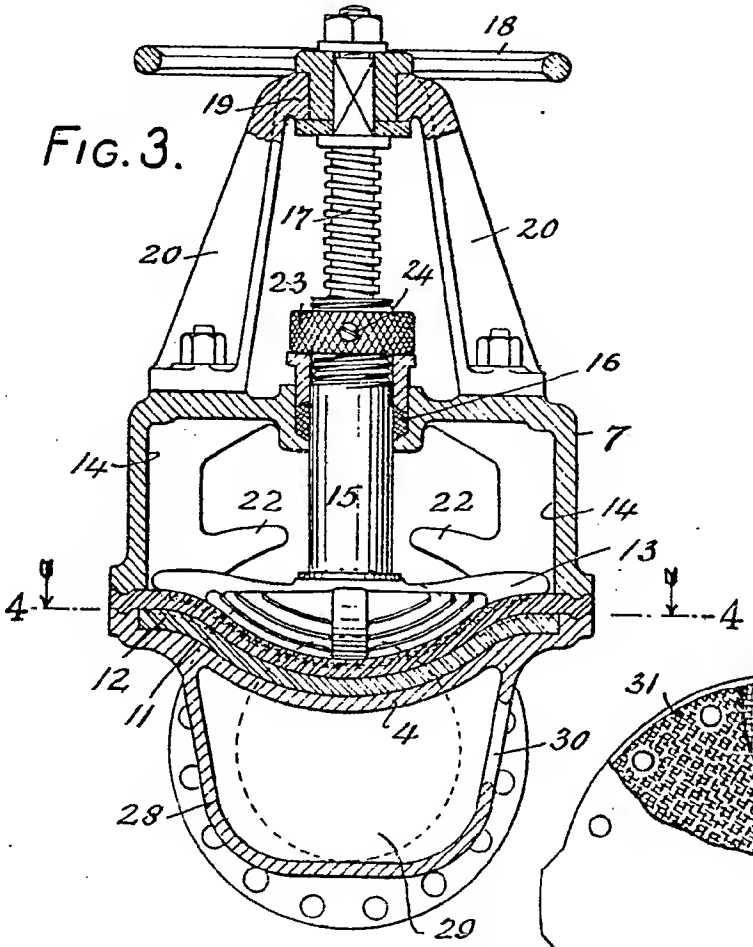


FIG. 5.

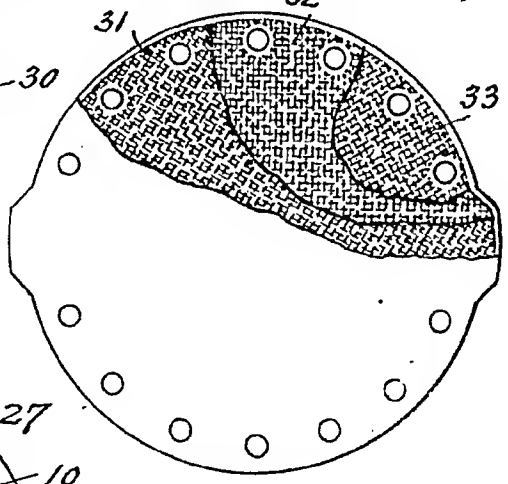
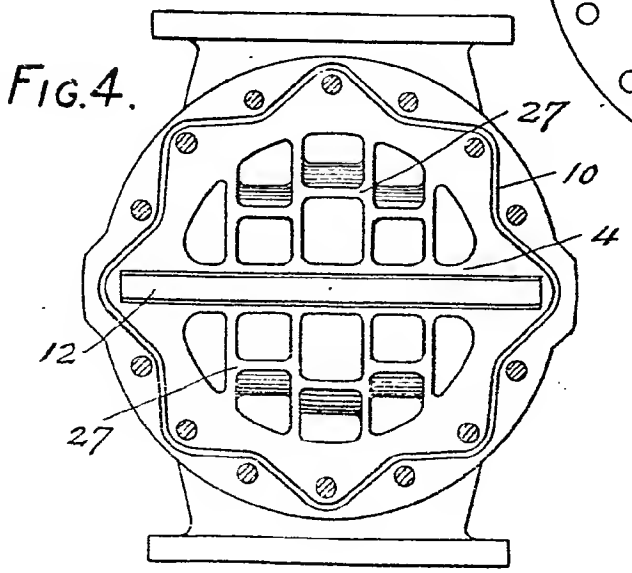


FIG. 4.



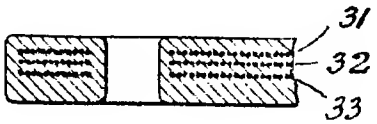


FIG. 6.

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